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Phosphorus and Potassium Rates and Placement Methods for Corn and Soybean Managed with No-till or Tillage

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Abstract
No-till management for corn and soybean results in little or no incorporation of crop residues and fertilizer with soil. Subsurface banding phosphorus (P) and potassium (K) fertilizers with planter attachments could be more effective than broadcast fertilization, because in no-till with broadcast fertilizer, both nutrients accumulate at or near the soil surface. A long-term study was initiated in 1994 at the ISU Northwest Research Farm to evaluate P and K fertilizer placement for corn and soybean managed with no-till and chiselplow tillage.

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RFR-A1156

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Introduction

No-till management for corn and soybean results in little or no incorporation of crop residues and fertilizer with soil. Subsurface banding phosphorus (P) and potassium (K) fertilizers with planter attachments could be more effective than broadcast fertilization, because in no-till with broadcast fertilizer, both nutrients accumulate at or near the soil surface. A long-term study was initiated in 1994 at the ISU Northwest Research Farm to evaluate P and K fertilizer placement for corn and soybean managed with no-till and chisel-plow tillage.

Materials and Methods

The study consists of separate trials for P and K on an area with Galva and Primghar soils. Tillage and fertilizer treatments are applied for both crops, which are grown each year on adjacent field areas and are planted in a 30-in. row spacing. The tillage involves chisel-plowing cornstalks in the fall and disking in spring, and disking soybean residue in spring only. The planter has row cleaners and granulated fertilizer attachments. Fertilizer placement methods were broadcast, deep-band, and planter-band until 2000, when deep banding was discontinued. Results for all methods were summarized in a previous report. This report includes data only for broadcast and planter-band methods.

The broadcast fertilizers are applied in the fall, and planter bands are placed 2 in. below and 2 in. beside the seeds. Fertilizer rates for each method have been a control, one-half the estimated annual maintenance rate (28 lb P_2O_5/acre or 35 lb K_2O/acre), and twice these amounts (56 lb P_2O_5/acre or 70 lb K_2O/acre) broadcast annually or only once before corn or soybean. Other treatments evaluated include combining band and broadcast methods, and since 2001, annual application of 112 lb P_2O_5/acre or 140 lb K_2O/acre. Data for 2004 are not included in overall averages shown because a hailstorm markedly reduced crop yield.

Results and Discussion

Corn yield has been higher with tillage than with no-till for all treatments, but has not affected soybean yield consistently. The difference for corn across fertilized treatments shown in Tables 1 and 2 was nine bushels/acre for the 18-yr period and 15 bushels/acre for the last two years. The yield difference has been smaller in the dry years, larger with cool and wet springs, and tended to increase over time. Previous ISU research has shown that strip tillage done with deep-banding fertilizer and planting corn on top of the knife tracks (a treatment discontinued in 2000) increased corn yield, but never reached yield levels resulting from chisel-plow tillage.

Table 1 summarizes results for phosphorus. Phosphorus fertilizer has increased grain yield since the experiment began because the initial soil-test P was low. For the control plots the P soil levels have decreased to the Very Low class in the late 1990s. The yield increase due to P application for both crops has increased over time for no-till compared with tillage (48 to 56 bu/acre increase). In the early years there was no yield difference between the P rates, but since 2000 the high rate (56 lb P_2O_5/acre) has increased yield more than the low rate and the difference keeps increasing. The 56-lb annual rate increased soil-test P to the optimum class by the late 1990s and to the High class by 2006.

However, there has been no large or consistent differences between the P broadcast and band placement methods for any crop. Planter-band P usually has increased early crop growth significantly more than broadcast P, especially for corn (not shown). A similar result has been shown in four other similar long-term studies being conducted at other research farms and by other research on farmers' fields.

Potassium (Table 2) has not increased soybean yield but occasionally has increased corn yield mainly in recent years and for no-till. No yield response to K was expected initially because soil-test K was in the High class, but over time K soil test levels of the control plots have decreased to the Optimum level where small responses are expected. There has been no difference between broadcast and planter-band K application. Reports until 2001 have shown that the small corn yield responses to K were observed mainly for no-till and for the deep-band placement method (discontinued in 2001), which also included a small effect of zone tillage. Larger benefits of deep-band K were observed at other farms with lower soil-test K levels, but no benefit was observed for deep-band P at any location.

Results for treatments that combined the low P or K rates using broadcast and planter-band methods, applying rates of 56 lb P_2O_5/acre or 70 lb K_2O/acre for two years before corn or soybean, and (since 2001) applying higher annual P and K rates are not shown because effects on grain yield have been statistically similar to results shown in Tables 1 and 2.

Conclusions

Soybean yield has been similar for no-till and chisel-disk tillage, but yield of no-till corn has been consistently less than with tillage. High P and K rates broadcast or banded with the planter have not reduced this yield difference. Phosphorus fertilization has increased yield greatly in this initially low-testing soil, but K fertilizer increased yield only occasionally because initial soil-test K was high and levels of control plots only recently decreased to the Optimum interpretation class. A rate of 28 P_2O_5/acre/year maximized yield of both crops in the early years, but recently a 56-lb annual rate or twice this amount applied every-other year before corn or soybean has maximized yield. A significant effect of planter-band P on early corn growth compared with broadcast P has not translated into higher grain yield.

Table 1. Phosphorus effects on crop yield.

		Placement and lb P_2O_5/acre/year				
			Broadcast		Planter Band	
Period	Till†	Control	28	56	28	56
		-------- Corn yield (bu/acre) ---------				
1994-11	CH	129	161	169	163	170
	NT	105	151	161	154	159
2010-11	CH	166	207	211	201	211
	NT	123	182	197	189	198
		------- Soybean yield (bu/acre) -------				
1994-11	CH	40.5	48.8	50.1	49.4	50.8
	NT	37.4	48.3	50.8	49.2	50.1
2010-11	CH	49.9	60.7	61.1	60.3	61.6
	NT	43.9	61.5	63.1	61.5	61.4

†Till, tillage: CH = chisel-plow/disk; NT = no-till.

Table 2. Potassium effects on crop yield.

		Placement and lb K_2O/acre/year				
			Broadcast		Planter Band	
Period	Till†	Control	35	70	35	70
		-------- Corn yield (bu/acre) ---------				
1994-11	CH	152	154	155	156	156
	NT	143	147	147	146	147
2010-11	CH	204	210	209	205	213
	NT	185	194	196	192	200
		------- Soybean yield (bu/acre) -------				
1994-11	CH	46.8	47.1	46.1	46.8	46.4
	NT	46.0	47.4	46.9	46.6	47.2
2010-11	CH	62.8	63.5	62.5	63.3	62.0
	NT	60.0	63.1	63.9	63.9	63.2

†Till, tillage: CH = chisel-plow/disk; NT = no-till.